Professional Competence, Attitudes, and Practices of Senior High School Chemistry Teachers in Organising Practical Work in the Greater Accra Region of Ghana

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ABSTRACT

Chemistry practical work is an essential component of science education that promotes learners' conceptual understanding and the development of scientific process skills. However, the effectiveness of practical instruction depends largely on teachers' professional competence, attitudes, and classroom practices. This study examined senior high school chemistry teachers' professional competence, attitudes, and practices in organizing practical work in the Greater Accra Region of Ghana. A descriptive survey design was employed, and 170 chemistry teachers from 34 public senior high schools were selected through simple random sampling. Data were collected using a structured questionnaire and an observation checklist. Descriptive statistics were used to analyse the data. The findings revealed that chemistry teachers generally possessed a high level of professional competence in organizing practical work. Teachers demonstrated the ability to provide clear explanations, conduct demonstrations, prepare reagents, handle laboratory equipment, and utilize digital resources to support instruction. Despite this high level of competence, teachers exhibited largely moderate to negative attitudes toward practical work. Observation data further revealed weaknesses in classroom practices, including inadequate supervision of students during practical activities, limited integration of real-life experiences into instruction, and the absence of laboratory manuals during practical sessions. In addition, practical tasks were not consistently selected from Ghana Education Service-approved instructional materials. The study concludes that a gap exists between teachers' professional competence and their actual implementation of practical work. While teachers possess the necessary knowledge and skills, attitudinal and contextual factors appear to hinder effective classroom practice. The study recommends continuous professional development programmes aimed at strengthening positive attitudes toward practical work and enhancing the effective implementation of practical activities in senior high schools.

Keywords: Chemistry Education, Practical Work, Professional Competence, Teacher Attitudes, Teaching Practices, Laboratory Instruction.

INTRODUCTION

Chemistry occupies a central position in science education because it provides learners with the knowledge and skills necessary for understanding the composition, properties, and transformations of matter (National Council for Curriculum and Assessment [NaCCA], 2019). As one of the elective science subjects offered at the senior high school level, chemistry contributes significantly to the development of scientific literacy, problem-solving abilities, and technological advancement (Baur & Emdem, 2021). The subject also serves as a foundation for careers in medicine, engineering, agriculture, environmental science, pharmacy, and other science-related professions. Consequently, effective chemistry instruction is essential for preparing learners to contribute meaningfully to national development and the knowledge-based economy (Ahmad et.al, 2023).

The teaching and learning of chemistry involve both theoretical and practical components. While theoretical instruction enables learners to understand scientific concepts and principles, practical work provides opportunities for learners to apply these concepts through direct observation, experimentation, and manipulation of materials. Practical work is therefore widely regarded as an indispensable aspect of chemistry education because it helps learners bridge the gap between abstract scientific concepts and real-world phenomena (Chen &Chen, 2021). Through practical activities, students develop scientific process skills such as observation, measurement, classification, experimentation, data recording, analysis, and interpretation. Practical work also promotes critical thinking, problem-solving skills, creativity, and scientific inquiry (Oliveira & Bonito, 2023).

Research has consistently demonstrated the educational value of practical work in science teaching. Studies have shown that practical activities enhance students' conceptual understanding, improve retention of scientific knowledge, increase motivation toward science learning, and foster positive attitudes toward science subjects. Practical experiences also help learners develop confidence in the use of laboratory equipment and scientific procedures while promoting collaborative learning and communication skills (Chu, 2024). In chemistry education particularly, practical work enables students to visualize chemical processes that are otherwise difficult to comprehend through theoretical instruction alone (Yao, 2023).

Despite its recognized importance, the implementation of practical work in many secondary schools remains problematic, particularly in developing countries. Several studies have reported challenges such as inadequate laboratory facilities, insufficient equipment and reagents, overcrowded classrooms, limited instructional time, and inadequate funding for science education (Mahama, 2022: Hussein, 2023). While these infrastructural constraints are significant, growing evidence suggests that teacher-related factors play an equally important role in determining the effectiveness of practical work implementation (Astro, 2023). Among these factors, teachers' professional competence, attitudes, and classroom practices have received considerable attention in science education research.

Professional competence refers to the knowledge, skills, abilities, and professional dispositions that enable teachers to perform their instructional responsibilities effectively (Hill & Chin, 2018). In the context of chemistry practical work, competent teachers are expected to possess adequate subject matter knowledge, laboratory management skills, pedagogical knowledge, and the ability to guide students through scientific investigations (Deng et.al, 2025). Competent teachers should be able to prepare laboratory activities, demonstrate experimental procedures, provide clear explanations, ensure laboratory safety, facilitate student engagement, and assess practical learning outcomes effectively. Professional competence is therefore considered a critical determinant of successful practical work implementation.

Teacher attitudes also influence the quality of practical science instruction. Large-scale meta-analytic evidence indicates that teachers' attitudes towards inclusive education are generally positive and have improved over time, with variations influenced by contextual factors such as national development levels and teacher specialisation (Guillemot, Lacroix & Nocus, 2022). Attitudes encompass teachers' beliefs, perceptions, feelings, and dispositions toward practical work and science teaching in general. Positive attitudes toward practical work is often associated with greater enthusiasm, commitment, and willingness to invest effort in organizing laboratory activities (Sshana & Abulibdeh, 2020). Conversely, negative attitudes may result in limited use of practical activities, reduced student engagement, and ineffective instructional practices (Darling-Hammond, 2021). Previous studies have reported that teachers who perceive practical work as beneficial are more likely to organize meaningful laboratory experiences for students than those who view practical activities as time-consuming, stressful, or resource-intensive.

In addition to competence and attitudes, teachers' actual classroom practices play a crucial role in determining the educational value of practical work. Effective practical work requires teachers to provide adequate supervision, encourage inquiry and experimentation, connect practical activities to theoretical concepts, ensure safe laboratory practices, and facilitate meaningful student participation (Oliveira & Bonito, 2023). However, evidence from several studies indicates that practical work is often implemented as a routine procedural exercise rather than an inquiry-based learning experience (Lesetja & Photo,2026). In many classrooms, students follow

predetermined instructions without sufficient opportunities to explore, investigate, or develop higher-order scientific thinking skills.

The relationship between teacher competence, attitudes, and instructional practices has been widely acknowledged in educational literature. Competent teachers are generally expected to demonstrate positive attitudes and effective classroom practices. However, research findings suggest that high levels of competence do not always translate into effective practical work implementation (Jentsch & König, 2022). Contextual challenges, workload pressures, inadequate motivation, and resource constraints may prevent teachers from applying their competencies fully in classroom practice (Creagh et.al, 2025). Understanding how these factors interact is therefore essential for improving the quality of practical science education.

In Ghana, practical work occupies an important place in the senior high school chemistry curriculum. The curriculum emphasizes the acquisition of scientific process skills, problem-solving abilities, and practical competencies through laboratory activities and investigations (NaCCA, 2020). Furthermore, practical work constitutes a significant component of the West African Senior School Certificate Examination (WASSCE), making effective practical instruction necessary for students' academic success. Despite these expectations, reports from the West African Examinations Council have consistently highlighted weaknesses in students' performance in chemistry practical examinations, including difficulties in conducting experiments, making accurate observations, interpreting results, and applying scientific concepts to practical situations (WAEC Chief Examiner's Report, 2024)

Several studies conducted in Africa have examined factors influencing practical work implementation and students' performance in science subjects. Findings from these studies suggest that teacher competence, attitudes, and instructional practices significantly influence the quality of practical science education (Hattingh, Aldous & Rogan, 2017). However, existing studies have largely focused on isolated aspects of practical work implementation, such as availability of resources, student achievement, or teacher competence. Few studies have simultaneously examined chemistry teachers' professional competence, attitudes, and classroom practices in organizing practical work within the Ghanaian senior high school context.

Moreover, empirical evidence regarding the interaction of these factors in the Greater Accra Region remains limited. As one of Ghana's foremost educational regions, with a high concentration of senior high schools and relatively better access to science resource facilities, the region offers a valuable context for investigating chemistry teachers' competence, attitudes, and practices. Understanding these dimensions is vital for informing educational policies and developing targeted professional development programmes to enhance the effectiveness of practical science instruction.

Therefore, this study examined senior high school chemistry teachers' professional competence, attitudes, and practices in organizing practical work in the Greater Accra Region of Ghana. Specifically, the study sought to determine the level of teachers' professional competence and attitudes toward practical work and to examine the practices employed by chemistry teachers in organizing practical activities in senior high schools.

Research Questions

The following questions were posed to guide the study:

1. What is the level of professional competence and attitudes of senior high school chemistry teachers in organizing practical work in the Greater Accra Region of Ghana?

2. What practices do senior high school chemistry teachers employ in organizing practical work in the Greater Accra Region of Ghana?

METHODOLOGY

This study adopted a descriptive survey design to examine senior high school chemistry teachers' professional competence, attitudes, and practices in organising practical work in the Greater Accra Region of Ghana. The

descriptive survey design was considered appropriate because it allows for the collection of data from a relatively large population and enables the description of existing conditions as they naturally occur without manipulation of variables. This design is suitable for studies that seek to obtain factual information on teachers' perceptions, competencies, and classroom practices within real educational setting (Siedlecki, 2020)

The study was conducted in public senior high schools in the Greater Accra Region of Ghana. The region was selected due to its high concentration of senior high schools offering science programmes and its relatively better availability of science resource centres that support practical instruction. The region comprises 44 public senior high schools distributed across metropolitan, municipal, and district assemblies.

The target population for the study consisted of all chemistry teachers in public senior high schools in the Greater Accra Region, while the accessible population comprised chemistry teachers with at least three years of teaching experience. A total of 170 chemistry teachers were selected from 34 randomly chosen senior high schools. Both schools and teachers were selected using a simple random sampling technique to ensure that each teacher had an equal chance of being included in the study. The sample included 140 male and 30 female teachers.

Data were collected using a structured closed-ended questionnaire and an observation checklist. The questionnaire was adapted from Ofori-Appiah et al. (2020) and was designed to measure teachers' professional competence, attitudes, and practices in organising chemistry practical work. The instrument consisted of three sections covering professional competence, attitudes, and practices, with items rated on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The observation checklist, comprising 15 items, was used to assess teachers' actual classroom practices during practical lessons, focusing on areas such as lesson preparation, supervision of students, use of laboratory materials, safety procedures, and student engagement. The observation data were used to triangulate responses obtained from the questionnaire.

The validity of the instruments was established through expert review by senior lecturers in Science and Chemistry Education at the University of Education, Winneba. The experts examined the instruments for clarity, relevance, and adequacy of coverage, and their feedback was used to refine the final versions prior to data collection. The reliability of the questionnaire was determined using Cronbach's alpha, which yielded a coefficient of 0.863, indicating high internal consistency. The observation checklist was further tested for inter-rater reliability using Cohen's kappa, which produced a coefficient of 0.75, indicating acceptable agreement between observers.

Permission to conduct the study was obtained from the Greater Accra Regional Directorate of the Ghana Education Service and from heads of participating schools. Informed consent was obtained from all respondents prior to data collection, and participation was voluntary. Confidentiality and anonymity were assured throughout the study. The questionnaire was administered with the assistance of trained research assistants and retrieved on the same day, resulting in a 100% response rate. In addition, classroom observations were conducted during chemistry practical lessons. Due to logistical constraints, two teachers from two schools were observed during practical sessions lasting approximately 80 minutes each.

Data were analysed using descriptive statistics with the aid of the Statistical Package for Social Sciences (SPSS). Frequencies, percentages, and mean scores were used to summarise the data. Mean scores were interpreted using a five-point Likert scale, where higher values indicated higher levels of competence, more positive attitudes, or better practices. For interpretation, mean scores were categorised as follows: 1.00–2.49 (low/negative), 2.50–3.49 (moderate), and 3.50–5.00 (high/positive).

RESULTS

Demographic Characteristics of Respondents

The demographic characteristics of the respondents were examined to provide background information on the chemistry teachers who participated in the study. Information collected included gender, age, teaching experience, educational qualification, area of specialisation, professional status, and participation in in-service

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training programmes. These characteristics are important because they may influence teachers' professional competence, attitudes, and practices in organising practical work. The results are presented in Table 1.

Table 1. Demographic characteristics of respondents (N=170)

Variables	No. of Respondents	Percentages (%)
Sex category		
Male	140	82.4
Female	30	17.6
Age (years)		
Below 26	2	1.2
26 – 30	30	17.6
Above 30	138	81.2
Years of Teaching Experience		
3 – 5	66	38.8
6 – 8	46	27.1
9 – 11	22	12.9
12 – 14	8	4.7
Above 14	28	16.5
Highest Educational Qualification		
Diploma	0	0.0
1st Degree	128	75.3
2nd Degree	42	24.7
Area of Specialization		
Chemistry	146	85.9
Other science aspects	24	14.1
Professional status		
Professional	130	76.5
Non-professional	40	23.5
In-service training attendance		

Yes	138	81.2
No	32	18.8
In-service training organizer		
GES	94	68.1
GAST	10	7.3
School	32	23.2
Kofi Annan Institute	2	1.4

"Percentages for in-service training organisers are based on respondents who reported attending in-service training (n = 138)."

The results from Table 1 indicate that the majority of the respondents were male (82.4%), while females constituted 17.6% of the sample. This suggests that chemistry teaching in the selected senior high schools was predominantly male-dominated.

With regard to age, most of the respondents (81.2%) were above 30 years, whereas 17.6% were between 26 and 30 years, and only 1.2% were below 26 years. This implies that the respondents were generally matured suggesting an experienced teaching population.

Concerning teaching experience, 38.8% of the respondents had taught for 3–5 years, while 27.1% had between 6 and 8 years of teaching experience. Teachers with more than 14 years of teaching experience constituted 16.5% of the sample. The distribution indicates that the study involved teachers with varying levels of professional experience.

In terms of educational qualifications, the majority of the respondents (75.3%) held a first degree, while 24.7% possessed a second degree. None of the respondents held a diploma as their highest qualification. Furthermore, 85.9% specialised in Chemistry, whereas 14.1% specialised in other science-related disciplines, suggesting that most participants had formal training in the subject they taught.

The findings also revealed that 76.5% of the respondents were professionally trained teachers, while 23.5% were non-professional teachers. In addition, 81.2% had participated in in-service training programmes, compared to 18.8% who had not attended any in-service training. Among those who attended in-service training, the Ghana Education Service (GES) was the major organiser (68.1%), followed by schools (23.2%), the Ghana Association of Science Teachers (GAST) (7.3%), and the Kofi Annan Institute (1.4%).

Overall, the demographic characteristics suggest that the respondents were generally experienced, professionally trained, and academically qualified chemistry teachers, thereby providing credible information regarding the organisation of chemistry practical work in senior high schools.

Professional Competence and Attitudes of Chemistry Teachers

Research Question 1:

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Weighted Mean
1. Giving clear explanation before practical work	86 (50.6%)	36 (21.2%)	0(0.0%)	16 (9.4%)	32 (18.8%)	3.15

2. Demonstrate experiments before students carry out the experiment	74 (43.5%)	48 (28.2%)	48 (28.2%)	0 (0.0%)	0 (0.0%)	3.05
3. Helping students to write reports on experiments	34 (20.0%)	48 (28.2%)	38 (22.4%)	48 (28.2%)	32 (18.8%)	3.04
4. Preparing reagents and solutions for titration experiments	86 (50.6%)	28 (16.5%)	38 (22.4%)	18 (10.6%)	0 (0.0%)	3.93
5. Designing laboratory manual to serve as a guide for students	50 (29.4%)	66 (38.8%)	30 (17.6%)	24 (14.1%)	0 (0.0%)	3.34
6. Arrange field trips for students	36 (21.2%)	26 (15.3%)	54 (31.8%)	42 (24.7%)	12 (7.1%)	2.16
7. Connecting glassware for laboratory synthesis of gases	24 (14.1%)	46 (27.1%)	80(47.1%)	20 (18.8%)	0 (0.0%)	3.16
8. Organising laboratory practical for the identification of ions	66 (38.8%)	70 (41.2%)	18 (10.6%)	16 (9.4%)	0 (0.0%)	3.02
9. Linking lesson with experience	0 (0.0%)	0 (0.0%)	34 (20.0%)	66(38.8%)	70 (41.2%)	1.78
10. Linking the concrete and abstract experiences of students	0 (0.0%)	(0.0%)	32 (18.8%)	68 (40.0%)	70 (41.2%)	1.78
11. Using the internet to gather information for students	70 (41.2%)	68 (40.0%)	32 (18.8%)	0 (0.0%)	0 (0.0%)	3.78
12. Defining problem (topic) in simple language	86 (50.6%)	46 (27.1)	22 (12.9%)	16 (9.4%)	0 (0.0%)	3.81
13. Handling all instruments and glassware	66 (38.8%)	72 (42.4%)	16 (9.4%)	16 (9.4%)	0 (0.0%)	3.89

What is the level of professional competence and attitudes of senior high school chemistry teachers in organizing practical work in the Greater Accra Region of Ghana?

Professional Competence of Chemistry Teachers

This section presents the results on the professional competence of chemistry teachers in organising practical work in senior high schools. Professional competence was assessed using items that measured teachers' ability to plan, organise, and facilitate practical activities, manage laboratory resources, demonstrate experiments, and apply appropriate instructional strategies during practical lessons. The respondents' ratings on the various competence indicators were analysed using mean scores and standard deviations. The results are presented in Table 2. with a summary in Table 3.

Table 2. Summary of chemistry teachers' competency level in organising practical work

Competence Level	Frequency	Percentage
High	120	70.6
Moderate	34	20.0
Low	16	9.4
Total	170	100.0

The findings from Tables 2 and 3 indicate that chemistry teachers demonstrated a generally high level of competence in organizing practical work, with 70.6% classified as highly competent, 20.0% as moderately competent, and only 9.4% as having low competence. This distribution suggests that, at a structural level, most teachers possess the foundational capacity required for effective laboratory-based instruction.

Among the competence indicators, the highest mean score was recorded for preparing reagents and solutions for titration experiments (M = 3.93), followed by handling laboratory instruments and glassware (M = 3.89), defining topics in simple language (M = 3.81), and using the internet to gather information for students (M = 3.78). These findings suggest that the respondents possessed strong technical and pedagogical skills required for the effective organisation of chemistry practical work.

Similarly, respondents reported competence in demonstrating experiments before students perform them (M = 3.05), helping students to write experimental reports (M = 3.04), organising laboratory practical activities for the identification of ions (M = 3.02), and designing laboratory manuals to guide students during practical work (M = 3.34). These competencies are essential for facilitating meaningful laboratory experiences and promoting students' understanding of scientific concepts.

However, relatively low mean scores were recorded for arranging field trips for students (M = 2.16), linking lessons with students' experiences (M = 1.78), and linking concrete and abstract experiences of students (M = 1.78). These findings suggest that although teachers were generally competent in the technical aspects of practical work, they experienced difficulties in integrating experiential and contextual learning approaches into chemistry instruction.

Overall, the findings indicate that chemistry teachers possessed the requisite professional competence for organising practical work in senior high schools. Nevertheless, there is a need to strengthen teachers' capacity to connect practical activities to students' real-life experiences and to incorporate more experiential learning opportunities into chemistry instruction.

Attitudes of Chemistry Teachers Toward Practical Work

This section presents the findings on chemistry teachers' attitudes towards the organisation of practical work in senior high schools. Attitudes were measured using a set of statements designed to capture teachers' feelings, perceptions, and dispositions towards planning and implementing chemistry practical activities. Respondents indicated their level of agreement using a five-point Likert scale. The results are presented in Table 4**.**

Table 4. Attitudes of chemistry teachers' toward organising practical work

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Weighted Mean
1. I like chemistry practical	46(27.1%)	0(0.0%)	46(27.1%)	24(14.1%)	54(31.8%)	2.76

2. I wish I don't have chemistry practical often	40(23.5%)	94(55.3%)	24(14.1%)	12(7.1%)	0(0.0%)	2.05
3. Chemistry practical helps me to teach the theory well in class	0(0.0%)	42(24.7%)	24(14.1%)	80(47.1%)	24(14.1%)	2.49
4. Chemistry practical motivates students	40(23.5%)	0(0.0%)	40(23.5%)	18(10.6%)	72(42.4%)	2.52
5. I like to expose my students more to science equipment during practical	0(0.0%)	38(21.2%)	24(14.1%)	108(63.5%)	2(1.2%)	2.60
6. I like working with science equipment despite the problems I have when using them	52(30.6%)	2(1.2%)	94(55.3%)	6(3.5%)	16(9.4%)	3.40
7. Chemistry practical makes me appreciate chemistry better	12(7.1%)	0(0.0%)	48(28.2%)	60(35.3%)	50(29.4%)	2.20
8. Write-up in chemistry practical is a very useful exercise	34(20.0%)	16(9.4%)	24(14.1%)	50(29.4%)	46(27.1%)	2.66
9. Chemistry practical help me acquire scientific skills	0(0.0%)	12(7.1%)	46(27.1%)	64(37.6%)	48(28.2%)	2.13
10. Chemistry practical is boring	22(12.9%)	34(20.0%)	24(14.1%)	36(21.2%)	54(31.8%)	3.39

Table 5. Summary of respondents' attitude toward organising practical work

Attitude Level	Frequency	Percentage
Good	50	29.4
Moderate	80	47.1
Bad	40	23.5
Total	170	100.0

The findings in Table 4 indicate that chemistry teachers' attitudes towards practical work were generally moderate, with a tendency towards negative dispositions in some areas. This is further supported by the summary of responses in Table 5, where 29.4% of respondents demonstrated good attitudes, 47.1% exhibited moderate attitudes, and 23.5% showed poor attitudes towards organising practical work.

Item-level analysis shows mixed perceptions among respondents. While a proportion of teachers indicated that they like chemistry practical work (M = 2.76), a substantial number disagreed, suggesting divided opinions. Similarly, although some respondents acknowledged that practical work motivates students (M = 2.52), many expressed disagreement, indicating uncertainty about its motivational value in classroom practice.

A relatively positive response was observed for the statement that teachers like working with science equipment despite challenges (M = 3.40), suggesting that some teachers remain willing to engage with practical activities even under difficult conditions. However, this positive disposition is not consistent across all indicators, as other items reflect less favourable attitudes.

For instance, many respondents indicated disagreement with the view that chemistry practical work helps them appreciate the subject better (M = 2.20) and that it enhances their acquisition of scientific skills (M = 2.13). In addition, a notable proportion of teachers agreed that chemistry practical work is boring (M = 3.39), further reinforcing the presence of negative perceptions among some respondents.

The finding that a significant proportion of teachers wish to avoid frequent practical sessions (M = 2.05) is particularly concerning, as it suggests reluctance towards regular implementation of laboratory-based instruction. This may have implications for the quality and consistency of practical science teaching in senior high schools.

Overall, the results indicate that although some chemistry teachers hold positive attitudes towards practical work, the dominant pattern is one of moderate or ambivalent attitudes with pockets of negative perceptions. This suggests that teachers may recognise the importance of practical work but are constrained by factors such as workload, resource limitations, and classroom management challenges, which may influence their enthusiasm for its regular implementation.

Practices of Chemistry Teachers in Organising Practical Work

This section presents the findings on chemistry teachers' classroom practices in organising practical work in senior high schools. Practices were examined using an observation checklist and questionnaire items that assessed how teachers implement practical activities during chemistry instruction. The results are presented in Table 6.

Research Question 2:

What practices do senior high school chemistry teachers employ in organising practical work in the Greater Accra Region of Ghana?

Table 6. Chemistry teachers' practices in organising practical work

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Weighted Mean
1. I supervise what students do during practical	42(24.7%)	32(18.8%)	16(9.4%)	54(31.8%)	26 (15.3%)	3.06
2. I teach the theory before students perform the practical	78(45.9%)	48(28.2%)	0(0.0%)	0(0.0%)	44(25.9%)	3.68
3. I allow students to work in groups during practical lessons	74(43.5%)	0(0.0%)	16(9.4%)	54(31.4%)	26(15.3%)	3.25
4. I give students immediate feedback	86(50.6%)	0(0.0%)	58(34.1%)	0(0.0%)	26(15.3%)	3.71

when they need directions to proceed.						
5. The theory lessons are not linked to real life situation	0(0.0%)	18(10.6%)	16(9.4%)	74(43.5%)	62(36.5%)	4.06
6. I organise group work because there are not enough reagents and glassware	94(55.3%)	32(18.8%)	18(10.6%)	0(0.0%)	26(15.3%)	3.99
7. I don't go around supervising students during practical	60(35.3%)	32(18.8%)	52(30.6%)	0(0.0%)	26(15.3%)	2.41
8. I provide the appropriate instruments for chemistry practical	110(64.7%)	16(9.4%)	18(10.6%)	0(0.0%)	26(15.3%)	4.08
9. Students perform chemistry practical in the school laboratory without any guidance	74(43.5%)	0(0.0%)	16(9.4%)	18(10.6%)	62(36.5%)	3.04
10. There is no equipment/ glassware or materials in the school laboratory, so I do not organize chemistry practical.	0(0.0%)	68(40.0%)	16(9.4%)	18(10.6%)	68(40.0%)	3.51
11. Students don't get the opportunity to handle every piece of the instruments in our school laboratory	0(0.0%)	42(24.7%)	34(20.0%)	68(40.0%)	26(15.3%)	3.46
12. The instrument in the laboratory give inaccurate results	42(24.7%)	0(0.0%)	16(9.4%)	86(50.6%)	26(15.3%)	3.31
Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Weighted Mean
13. I allow students to design their own experiments during chemistry practical	36(21.2%)	42 (24.7%)	16(9.4%)	50(29.4%)	26(15.3%)	2.95
14. I allow the students to perform experiments based on WAEC past questions	36(21.2%)	50(29.4%)	16(9.4%)	68(40.0%)	0(0.0%)	3.32

15. I select practical task from GES approved textbooks	36(21.2%)	0(0.0%)	16(9.4%)	50(29.4%)	68(40.0%)	2.33
16. I have enough chemical for chemistry practical.	36(21.2%)	74(43.5%)	34(20.0%)	0(0.0%)	26(15.3%)	3.55
17. Where there are no materials (glassware, equipment) I improvise	36(21.2%)	42(24.7%)	16(9.4%)	50(29.4%)	26(15.3%)	3.07

Table 7. Summary of chemistry teachers' practices in organising practical work

Practice Level	Frequency	Percentage
Good	26	15.3
Moderate	34	20.0
Poor	110	64.7
Total	170	100.0

The findings in Table 6 reveal mixed practices among chemistry teachers regarding the organisation of practical work. However, the overall results presented in Table 7 indicate that the majority of respondents (64.7%) exhibited poor practices, while 20.0% demonstrated moderate practices and only 15.3% displayed good practices. These findings suggest that although teachers may possess the necessary professional competence, this competence is not consistently translated into effective classroom practice.

The item-level analysis shows that several positive practices were reported by the respondents. Teachers generally indicated that they taught the theoretical aspects of a topic before conducting practical activities (M = 3.68), provided immediate feedback to students during practical sessions (M = 3.71), and supplied appropriate instruments for practical work (M = 4.08). In addition, many respondents reported having sufficient chemicals for practical activities (M = 3.55) and organising group work during practical lessons (M = 3.25). These findings suggest that teachers make efforts to prepare students for practical activities and ensure the availability of essential instructional resources.

The results further revealed that teachers frequently organised students into groups because of inadequate reagents and laboratory equipment (M = 3.99). Although group work is recognised as a useful instructional strategy, the findings suggest that its use may often be driven by resource constraints rather than pedagogical considerations. Similarly, many teachers reported improvising materials when laboratory equipment and glassware were unavailable (M = 3.07), indicating attempts to address shortages in instructional resources.

Despite these positive practices, several areas of concern were identified. The findings indicate that teachers seldom allowed students to design their own experiments (M = 2.95), suggesting limited opportunities for inquiry-based learning and the development of independent scientific thinking. Furthermore, respondents reported low levels of selecting practical tasks from Ghana Education Service-approved textbooks (M = 2.33), which may affect the standardisation and quality of practical instruction.

The results also indicate weaknesses in supervision and learner support during practical sessions. Although some teachers reported supervising students during practical activities (M = 3.06), observation findings showed that supervision was often inadequate, and students occasionally conducted experiments without sufficient guidance. In addition, a considerable proportion of respondents indicated that students did not always have the opportunity

to handle all laboratory instruments (M = 3.46), potentially limiting the development of practical skills and hands-on experience.

In summary, the findings suggest that chemistry teachers' practices in organising practical work are generally inadequate despite the availability of some positive instructional behaviours. The predominance of poor practice levels may be attributed to factors such as inadequate laboratory resources, large class sizes, limited instructional time, and challenges associated with managing practical activities. These findings highlight the need for interventions aimed at strengthening the implementation of practical work and ensuring that teachers effectively translate their professional competence into classroom practice.

To validate the questionnaire data and obtain an objective account of classroom implementation, observational data were collected during chemistry practical lessons in selected senior high schools. The observation focused on key instructional activities such as teacher preparation, supervision, student engagement, use of instructional materials, and adherence to safety and procedural guidelines. The results of the observations from a Municipal Assembly (TMA) school and a District Assembly (TDA) school are presented in Table 8.

Table 8: Observational Data on Chemistry Teachers' Practical Work Practices (n = 40)

S/N	Activity	Yes (%)	No (%)
1	Teacher sets up practical work for students	36 (90.0)	4 (10.0%)
2	Teacher gives clear explanation before practical work	38 (95.0)	2 (5.0%)
3	Teacher links theory lessons with real-life situations	8 (20.0)	32 (80.0%)
4	Teacher supervises students during practical tasks	10 (25.0)	30 (75.0%)
5	Students use appropriate glassware/instruments	34 (85.0)	6 (15.0%)
6	Students follow rules and guidelines during practical work	12 (30.0)	28 (70.0%)
7	Students work in groups during practical lessons	32 (80.0)	8 (20.0%)
8	Teacher teaches theory before practical is organised	37 (92.5)	3 (7.5%)
9	Teacher provides immediate feedback to students	33 (82.5)	7 (17.5%)
10	Teacher provides enough reagents/instruments	35 (87.5)	5 (12.5%)
11	Teacher monitors correct use of chemicals	11 (27.5)	29 (72.5%)
12	Teacher moves around to supervise individual work	9 (22.5)	31 (77.5%)
13	Teacher motivates students during practical work	30 (75.0)	10 (25.0%)
14	Teacher provides practical manuals for students	7 (17.5)	33 (82.5%)
15	Students are given enough time to complete tasks	34 (85.0)	6 (15.0%)

The observational data presented in Table 8 provide important insights into the actual classroom practices of chemistry teachers during practical lessons. The results indicate that teachers were generally strong in the preparatory and organisational aspects of practical instruction. A high proportion of teachers were observed setting up practical work (90.0%), providing clear explanations before experiments (95.0%), and teaching theoretical concepts prior to practical activities (92.5%). In addition, most teachers ensured the availability of

appropriate reagents and instruments (87.5%), provided immediate feedback to students (82.5%), and allocated sufficient time for the completion of practical tasks (85.0%). These findings suggest that teachers are well-prepared to initiate and manage laboratory activities.

However, the results also reveal notable deficiencies in the implementation of inquiry-based and student-centred practices. A relatively small proportion of teachers were observed linking practical activities to real-life situations (20.0%), supervising students during practical tasks (25.0%), and actively monitoring the correct use of chemicals (27.5%). Furthermore, only a few teachers moved around the laboratory to provide individual supervision (22.5%), and the provision of structured practical manuals was also limited (17.5%). These gaps suggest that while practical lessons are conducted, they are not consistently implemented in a manner that promotes guided inquiry, safety awareness, and meaningful student engagement.

The findings further indicate that although students were often organised into groups (80.0%) and provided with appropriate equipment (85.0%), their learning experiences were not always closely monitored or adequately structured. This may limit opportunities for students to develop scientific process skills, independent inquiry, and conceptual understanding of chemistry concepts.

Taken together, the observational findings corroborate the questionnaire data and confirm that although chemistry teachers demonstrate strong competence in organising practical activities, their classroom implementation practices remain weak in key pedagogical areas such as supervision, inquiry-based learning, and contextual linkage of concepts. This reinforces the existence of a clear disconnect between teachers' professional competence and effective classroom practice in the teaching of chemistry practical work.

DISCUSSION

This study examined senior high school chemistry teachers' professional competence, attitudes, and practices in organising practical work in the Greater Accra Region of Ghana. The findings provide important insights into the extent to which teachers possess the competencies required for practical instruction and how these competencies are reflected in their classroom practices.

The findings revealed that chemistry teachers generally demonstrated a high level of professional competence in organising practical work. Teachers reported being capable of providing clear explanations before practical lessons, demonstrating experiments, preparing reagents and solutions, handling laboratory equipment, and utilising information and communication technology to support practical instruction. These findings suggest that teachers possess the pedagogical and content knowledge required for effective laboratory-based instruction. This aligns with the view of Chen and Chen (2021), who emphasised that teachers' practical knowledge plays a critical role in facilitating practical work. Similarly, Gess-Newsome (2015) and Deng et al. (2025) argue that pedagogical content knowledge is a key determinant of effective science teaching. The findings further support the view that professionally competent teachers are better positioned to organise practical activities, facilitate student learning, and manage laboratory environments effectively (Koksal, 2014; Deakin, 2008). However, the findings contrast with studies conducted in some developing contexts where science teachers have been reported to possess relatively low levels of competence due to inadequate training and limited opportunities for professional development (Adikwe et al., 2018).

Despite the high level of competence demonstrated by teachers, the study found that their attitudes towards organising practical work were generally moderate to negative. A considerable proportion of respondents expressed limited enthusiasm for practical lessons and indicated reluctance towards organising practical activities frequently. This finding is of concern because attitudes influence teachers' willingness to apply their competencies effectively in classroom practice. The moderate to negative attitudes observed among teachers may reflect the demanding nature of practical instruction, which often requires extensive preparation, laboratory organisation, procurement of materials, and close supervision of students. In situations where teachers face large class sizes, inadequate laboratory facilities, limited technical support, and heavy teaching workloads, practical work may be perceived as burdensome despite its recognised educational value. This explanation is consistent with Niwas (2018), who reported that teacher attitudes significantly influence instructional effectiveness, and

with Creagh et al. (2025), who identified workload pressures as a major challenge affecting teachers' professional practice.

The study further revealed that teachers' classroom practices in organising practical work were generally weak. Although teachers reported providing explanations and demonstrations before practical lessons, both questionnaire and observation data indicated deficiencies in important aspects of practical instruction. These included inadequate supervision of students during practical work, limited linkage of practical activities to real-life contexts, and inconsistent use of structured laboratory manuals. Such findings suggest that practical work is often implemented as a procedural exercise rather than as an inquiry-based learning process intended to develop scientific reasoning and problem-solving skills. These findings are consistent with Abrahams and Millar (2008), who observed that practical work in many school settings often becomes procedural rather than inquiry-oriented, thereby limiting its educational effectiveness. Similarly, Hofstein and Lunetta (2004) argued that poorly implemented laboratory work fails to promote meaningful conceptual understanding and scientific thinking.

The observational data further reinforced these findings. Although teachers were generally well prepared and ensured the availability of materials and equipment, they rarely moved around the laboratory to supervise individual learners, monitor the correct use of chemicals, or guide students through experimental procedures. In addition, practical activities were not consistently linked to real-life situations, and laboratory manuals were seldom provided to support student learning. Such practices reduce opportunities for learner engagement, inquiry, and the development of scientific process skills. These findings support the work of Hattingh, Aldous, and Rogan (2007), who identified inadequate supervision and insufficient instructional support as major factors affecting the quality of practical work in science classrooms.

One of the most significant findings of this study is the apparent disconnect between teachers' professional competence and their actual classroom practices. While teachers demonstrated high levels of competence, this did not consistently translate into effective implementation of practical work. This finding challenges the assumption that improving teacher competence alone will automatically improve classroom practice. Rather, the effective implementation of practical work appears to depend on the interaction between teacher competence, attitudes, resource availability, workload demands, and institutional support systems. Consequently, teachers may possess the knowledge and skills required for effective practical instruction but remain unable or unwilling to apply them fully within existing classroom conditions. Chen and Chen (2021) similarly noted that teacher knowledge does not automatically result in effective instructional practice when contextual barriers exist.

The competence–practice gap identified in this study is further supported by literature highlighting the influence of systemic and institutional constraints on classroom implementation. Mahama (2022), for example, reported that curriculum implementation in Ghana is often affected by resource limitations, inadequate support structures, and heavy teacher workloads. Likewise, Astoro (2023) found that teacher certification, academic supervision, and the availability of teaching facilities significantly influence instructional quality. These studies suggest that professional competence must be complemented by adequate institutional support and favourable teaching conditions if it is to translate into effective classroom practice.

Taken together, the findings suggest that improving chemistry practical work requires more than enhancing teachers' professional competence alone. There is a need to address attitudinal and contextual barriers that hinder the effective implementation of practical activities. Professional development programmes should therefore focus not only on strengthening technical competencies but also on fostering positive attitudes towards practical work and equipping teachers with strategies for implementing learner-centred and inquiry-based practical activities. Furthermore, educational authorities should ensure the adequate provision of laboratory facilities, reagents, instructional materials, and technical support to enable teachers to translate their competencies into effective classroom practices.

In summary, the study demonstrates that while chemistry teachers in the Greater Accra Region possess the professional competence required to organise practical work, their attitudes and classroom practices constrain the effective implementation of practical instruction. Strengthening the alignment between teacher competence, positive professional dispositions, and supportive classroom conditions is therefore critical for enhancing the

quality of chemistry practical work and promoting meaningful scientific learning among senior high school students

CONCLUSION

This study examined senior high school chemistry teachers' professional competence, attitudes, and practices in organising practical work in the Greater Accra Region of Ghana. The findings revealed that chemistry teachers generally possess a high level of professional competence in organising practical activities. However, despite this competence, teachers exhibited largely moderate to negative attitudes towards practical work, while their classroom practices were generally weak, particularly in areas such as student supervision, inquiry-based instruction, and the contextualisation of practical activities.

A major contribution of the study is the identification of a disconnect between teachers' professional competence and their actual classroom practices. The findings suggest that competence alone is insufficient to ensure the effective implementation of practical work. Rather, the translation of competence into practice is influenced by teachers' attitudes, availability of resources, workload demands, and institutional support systems.

The study therefore concludes that improving the quality of chemistry practical work in senior high schools requires a holistic approach that extends beyond the development of teacher competence. Educational authorities and school administrators should create supportive conditions that promote positive attitudes towards practical work, provide adequate laboratory resources, and strengthen professional development opportunities focused on inquiry-based and learner-centred practical instruction. Addressing these factors is essential for enhancing the effectiveness of chemistry practical work and improving students' acquisition of scientific knowledge, practical skills, and problem-solving abilities.

Declarations

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Ethics Approval and Consent to Participate

Permission to conduct the study was obtained from the Greater Regional Directorate of the Ghana Education Service (GES), heads of participating schools, and the relevant educational authorities. Participation in the study was voluntary, and informed consent was obtained from all participants before data collection. Participants were assured of anonymity and confidentiality, and all information collected was used solely for research purposes.

Consent for Publication

All authors have read and approved the final manuscript and consent to its publication.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Author Contributions

Clinton Appiah Kodom and Winfred Anim conceptualized and designed the study, developed the research instruments, collected the data, conducted the data analysis, interpreted the findings, and drafted the manuscript. Godfred Safo-Adu provided overall supervision of the research, contributed to the study design and methodology, guided the interpretation of the findings, critically reviewed the manuscript, and provided intellectual input throughout the research process. All authors read, revised, and approved the final manuscript

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